EMERGING ISSUES

Cracking the ozone code

Can gas drilling and clean air co-exist?

Researchers with the Uintah Basin Winter Ozone Study launch a blimp-shaped balloon in early 2011 to take air quality samples at various altitudes. COURTESY HOWARD SHORTHILL, UTAH STATE UNIVERSITY

On a bright February morning, a curiously adorned cargo van crept down a dirt road in northeastern Utah's Uintah Basin. A steel pole with a jumble of funnels strapped to its tip rose from the roof's rear, and the vehicle moved so slowly that its speed didn't even register — a good thing, considering that its occupants were less focused on the road than they were on their computer screen's undulating lines.

"We're on the edge of it now," said driver Peter Edwards, an air chemist with the National Oceanic and Atmospheric Administration. "The blue line is the methane — you'll see that jump right up. And we'll see the nitrogen oxide go up." As we entered a natural-gas well's plume, the funnels inhaled air, and instruments inside the van analyzed it. A decidedly low-tech piece of equipment — a piece of string tied to the antenna — stood rigid in the wind, allowing the researchers to eyeball which pieces of well-pad equipment they were downwind of when emissions spiked.

In recent years, frenzied drilling has brought many changes to this sparsely populated patch of the Colorado Plateau. Vernal, population around 9,000, has gained numerous hotels, a handful of Main Street retail stores, a Lowe's and several chain restaurants. Meanwhile, Uintah County's coffers have grown pleasantly plump with mineral royalties.

The boom has also brought some unexpected byproducts: concentrations of ground-level ozone that, on the worst days, rival those of the most polluted cities, where ozone and other airborne wastes combine to create smog. Ozone can cause acute respiratory ailments and aggravate asthma. At times, its concentrations here are almost double what the Environmental Protection Agency considers safe. (How the ozone has affected local health, though, has not been studied.)

It's a puzzling phenomenon that a team of NOAA scientists, including Edwards, spent this year trying to untangle. Unlike urban areas, where ozone events are a hallmark of summer, levels spike here in winter. So far, that is known to occur in only one other place in the world — Wyoming's Upper Green River Basin, home to the Jonah and Pinedale Anticline gas fields.

Effective strategies for stifling ozone have been slow to take shape, in large part because how it forms in winter is still only partially understood. Even basic data — such as the source-by-source emissions inventory the van was collecting — have been lacking. Many years into a region-wide drilling boom, this points to an uneasy reality: Energy development has significantly outpaced our grasp of its effects on the environment and public health.

"It's important to understand the impacts of our energy economy," says Jim Roberts, a NOAA scientist who headed up the Utah ozone research last winter. "We may need to make choices around that" — such as how rapidly we punch new wells, and how tightly drillers are required to control certain emissions. It's an issue of national importance, he says. "Why don't you see (wintertime ozone) in eastern Colorado? Why not western Pennsylvania or upstate New York?"

In 2005, the Wyoming Department of Environmental Quality began monitoring in the Upper Green River Basin in winter to get a handle on air quality before major oil and gas development occurred. Drilling had revved up the year before, and that first winter, ozone concentrations were nearly 25 percent above what's allowed under federal law.

The data shocked even the most well-versed ozone scientists. It's surprising enough to see this happening so far from the congested highways at the root of urban ozone and smog. But the timing of the episodes, in winter, was even more baffling, because the humidity and intense solar radiation thought necessary to start the chemical reaction that turns certain pollutants into ozone were missing.

By 2009, NOAA researchers had pieced together circumstantial information about Wyoming's worsening winter ozone events. Ozone spiked when temperature inversions trapped and concentrated pollutants near the valley floor. Extensive snow cover made a difference, too: Sunlight reflecting off it created enough radiation, scientists theorized, to set off the reactions that create ozone. In winter 2010, startlingly high ozone levels were documented in Utah's Uintah Basin under similar conditions.

In both places, booming natural gas fields seemed the source of ozone's primary ingredients: nitrogen oxides from diesel trucks and engines that run compressors and other equipment; and volatile organic compounds, present in the gas itself.

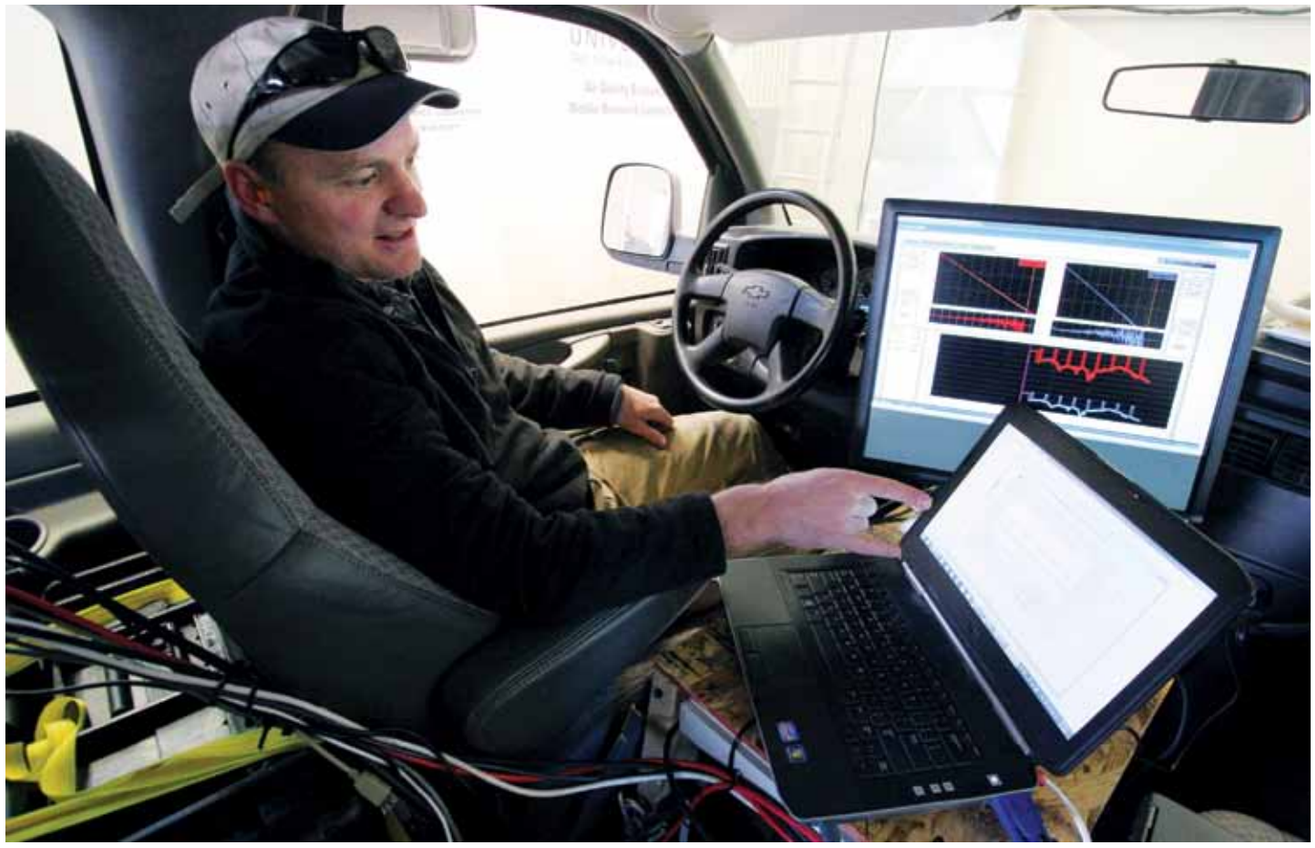
Knowing the source of emissions is enough to devise remedies for many pollution problems. Take sulfate particles, another contributor to smog. Power plants emit sulfur dioxide, which creates sulfate. When plants install scrubbers that capture most sulfur dioxide emissions, you get fewer sulfate particles in the air.

Ozone is much more complicated. "It's a weird beast," says Leonard Herr, the Bureau of Land Management's air-quality specialist for Utah. "You can't just control one thing." Nitrogen oxides (NOx) and volatile organic compounds (VOCs) are the basic building blocks, but you also need reactive atoms or molecules called free radicals — created when sunlight

Please see **Ozone**, *page 24*

BY CALLY CARSWELL

"The fundamental question is: Should you go after the volatile organic chemicals, or should you go after nitrogen oxides?" says Brock LeBaron, Utah's air quality department chief. Without an answer, it's hard to draft a sure-fire mitigation plan.



National Oceanic and Atmospheric Administration senior research associate Jon Kofler shows air quality readings from inside the ozone study's testing van at Utah State University Uintah Basin in Vernal in February 2012. GEOFF LIESIK, DESERET NEWS

Ozone *continued from page 9*

reacts with things like nitrous acid, a by-product of NOx, or ozone itself — to jump-start the process, the way a spark makes fire out of fuel. But there's no universal recipe; which free radicals react with which VOCs and NOx differs from region to region. Moreover, some environments are sensitive to NOx, meaning that if it's reduced, ozone will be too. Others are sensitive to VOCs. It's even possible to reduce NOx in a VOC sensitive environment, and end up slightly increasing ozone.

So managing ozone requires extraordinary prudence, plus a nuanced understanding of the chemistry that creates it in each locale. Neither Utah nor Wyoming has reached that level of understanding.

The NOAA team intended to change that. For six weeks last winter, they worked out of a sort of man camp in the heart of the gas field. A rental RV — housing for grad students monitoring a balloon measuring pollution above the surface — sat alongside trailers and what looked like miniature shipping containers, jammed with instruments measuring pollutants. Wind sensors helped the researchers see how plumes moved. And a team toured the field daily in the van, collecting real-time emissions data from each link of the production chain. If the chemists in the temporary labs could figure out which pollutants were the ozone conspirators, the van could help identify their origins.

Only two things were missing: snow and inversions. The scientists charged with unraveling the ozone riddle and recommending fixes found themselves in the ironic position of wishing for dirty days for the sake of science. But they never materialized. And so, there was no ozone to study.

"We're kind of stuck halfway right now," Roberts says. They did collect some information: They ruled out a nearby coal-fired power plant as a major contributor; although it spews plenty of NOx, its plume travels above the level of inversions. And they believe wintertime ozone has been seen only in the Utah and Wyoming basins because of the way topography restricts air movement during inversions. VOC emissions were found to be especially high from evaporation ponds and during flowback — the period after a well is hydrofractured when the fracking fluid, gas and other hydrocarbons are regurgitated. The compounds found aren't typically very reactive in small amounts, says Roberts, but their concentrations were

Beyond ozone

Wintertime ozone is just one surprising air-quality problem that has appeared as gas fields balloon in size and creep closer to communities. "It's possible that emissions have been there all along," since the industry isn't new, says Ramón Alvarez, an Environmental Defense Fund air-quality expert. But with drilling under increasing scrutiny, he says, "People are appropriately wondering, 'What does this mean for my health?' "

The answer remains largely unknown. "To determine a health effect, you need a large number of exposures occurring, and for them to occur over a long enough time for people to develop an effect," says Alvarez. "When you're in a rural environment, those things are hard to match up."

Still, researchers are trying to get a handle on health risks. A study by the Colorado School of Public Health found that the risk of cancer and other illnesses in Garfield County, Colo., was greatest for residents within a half-mile of wells, where volatile organic compounds around homes were documented at five times safe levels.

Another important question concerns the industry's carbon footprint. This year, emissions of methane – a powerful greenhouse gas – from Colorado's Denver-Julesburg Basin were found to be about twice as high as the industry had reported, raising doubts over whether natural gas truly is a more climate-friendly fuel than coal.

CALLY CARSWELL

very high. NOx levels were sufficient to create ozone, but not particularly high.

"We think there may be some chemistry happening in the snow itself," he says, but it couldn't be studied since there was no snow.

They suspect that this year, with no ozone events, was the anomaly, not the previous two, when snow cover was thick and ozone levels were frequently high. So NOAA, the state and their partners hope to procure funding to study the basin again next year. "The emissions inventory work, gathering fingerprints of sources was successful," says Brock LeBaron, head of air quality for the Utah DEQ, and the state's point person for the study. "Still, the fundamental question is: Should you go after the VOCs, or should you go after NOx?"

Without an answer, it's hard to draft a sure-fire mitigation plan. In the meantime, though, regulators in both Wyoming and Utah are "casting a big net" when it comes to pollution controls, as Wyoming's air quality chief, Steve Dietrich, puts it. "We'd be remiss if we concentrated on VOCs and didn't concentrate on NOx. So we're trying to reduce both of them."

"Green completions," which capture hydrocarbons and VOCs during flowback, are required throughout the Upper Green River Basin, and for new projects in the Uintah Basin, where such projects have been approved only if they install technology such as low-bleed valves to control VOC leaks from well-pad equipment; minimize truck trips; use clean-burning engines at drill rigs; and add any additional controls deemed necessary as regulators' understanding of local ozone chemistry advances. The state and BLM also hope to work with industry to ensure no net increase in emissions, beginning next winter. Wyoming drillers have taken similar steps. Most of these measures aren't legally required, but the industry and states have been trying to avoid becoming "non-attainment" zones for ozone pollution, an EPA designation that can bring mandatory — and probably expensive — regulations, and could limit new energy development.

Since 2009, the industry estimates that it's reduced VOC emissions by 21 percent, and NOx by 17 percent, in the Upper Green River Basin. Yet despite these emissions cuts, the problem persists. The EPA just declared the Upper Green River Basin a non-attainment zone, underscoring the need for better information to shape a strategy. Utah lacks such statistics because it's just begun requiring NOx and VOC controls of big new projects in development.

"The Uintah Basin has a couple years, probably, where we can try some out-of-the-box proactive strategies," before the EPA enters the fray, says the BLM's Herr. Still, in that short time, he says, "It's kind of a long shot that we'll be able to solve it." □

Following the wind

OPINION BY JOHN BERRY

There's action all around, with thousands of bats unspooling into four great ribbons to fly through this gantlet of Swainson's hawks.

On a Friday evening in the middle of August, there isn't much traffic along Franklin Boulevard, an old agricultural road that now cuts through 20 miles of Sacramento, Calif., suburbs. We're looking for birders along its half-mile length but don't see anybody — not even a parked car.

When a farmer drives his pickup out of a field and stops to lock a gate, I walk over and ask whether he's seen any hawks or bats in the neighborhood. He sure has, he says, because his family has farmed nearly 400 acres of this land for six generations. The bats are Mexican free-tailed bats, he says, and there are 30,000 to 40,000 of them roosting under the bridge right now. The hawks gather when it's time for the bats to emerge, and we'll hear them, he assures me.

As if on cue, a Swainson's hawk screams.

By the time we park and get across the road, four or five Swainson's have begun circling low over the riparian oak woods. We stand at the bridge's railing and peer at the floodplain below. A few bats shoot out. Soon a stream of the tiny mammals pours down from under the bridge, and the stream becomes a torrent. Bats swirl into a great boil before making a dash for the nearest oaks, where they rise into the canopy and form ribbons that wind westward into the orange sky.

That's what the hawks were waiting for. I spot a bird positioning itself above the nearest ribbon of bats, and then it plunges through, talons outstretched. A bat, still flapping, gets caught in a talon. The hawk quickly dispatches the bat and veers back for another pass. Now there's action all around, with thousands of bats unspooling into four great ribbons to fly through this gantlet of Swainson's hawks. No, it isn't only hawks. Two peregrine falcons have joined the hunt. Within minutes all the raptors have bulging crops.

Turning my binoculars toward the distant lead bats, now far out over the valley, I wonder how much longer this remarkable hunt can last. Despite the recession and the efforts of local conservation groups, Sacramento continues to sprawl, gobbling up farmland, grassland, and woodland to spit out legions of McMansions, retirement communities, and strip malls. With each advance of the developers' bulldozers, Swainson's hawk habitat is destroyed.

But a more immediate threat may come from the wind. Famous for their long-distance migration of more than 10,000 miles, Swainson's hawks follow the wind as far south as the Argentine pampas. Energy companies also follow the wind. Seven wind farms have been built in the Isthmus of Tehuantepec, Mexico, near a stretch of the flyway used by the vast majority of Swainson's hawks. Thirteen more are in development. Erecting thousands of wind turbines along a major migration corridor would seemingly fail a fundamental requirement for bird-safe wind energy: correct siting. A World Bank document about one of the Tehuantepec wind farms states that "avian impacts are not expected to be significant," but a case study of another wind farm admits "concern about the potential cumulative impacts of the many additional wind farms planned in the same general area."

Of course, the dangers posed by wind energy don't lie just south of the border. California has its own wind farms, and some are notorious for their raptor mortality. Several wind farms — comprising more than 700 turbines — have already been constructed in the Montezuma Hills of Solano County, an important part of the Swainson's hawk's historic breeding range.

Reviewing a draft environmental impact report for the latest proposed wind farm there, Friends of the Swainson's Hawk, a wildlife advocacy group, warns, "Over time, the project could have a significant impact on the range of the Swainson's hawk in California through higher than natural mortality rates and loss of foraging habitat used by nesting Swainson's hawks to feed their young." The project would be relatively small at just 50 turbines on about 3,000 acres, but it can only ratchet up the pressure on this threatened, distinctive population of this particular hawk. An unknown number of birds will be killed each year, and more habitat will be lost.

After 25 minutes, the bat exodus is coming to an end. We walk down the bridge, following the last bats across the Mokelumne, and almost run into a peregrine flying toward us. Startled, the bird banks and heads upriver into the night. We turn back toward the car. "Wow," says my mom, "that was incredible." □

John Berry, a Californian, now works and usually birds in New Jersey.

WEB EXTRA
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